Method: In-line Three-Channel Backscattering, WET Labs ECO BB3

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Brief description of protocol: Three-channel backscattering was obtained from continuous inline observations collected with a WETLabs ECO BB3 sensor using the differencing method between unfiltered and filtered observations following Slade et al. (2010). The backscattering sensor was comprised of 3 LEDs, nominally 412 nm, 595 nm, 715 nm. Sunstone Scientific calibrated the sensor just prior to the EXPORTS North Pacific expedition.

Deployment methodologies: A diaphragm pump installed in the sea chest of the R/V Armstrong delivered continuous seawater to the wet lab, with minimal particle disruption. The inline optical system consists of serial flow in the following order: MSRC VDB-1 vortex debubbler, Seabird thermosalinograph, Sequoia Flow Meter, WET Lab acs, WET Labs ECO 3X1M, WET Labs ECO BBFL2 and WET Labs ECO BB3. The ECO BB3 was configured in a custom-designed casket (Dall'olmo et al. 2009) that minimizes impacts of scattered light within the flow. The flow meter automatically switched flow from unfiltered to filtered through a large volume 0.2 μm cartridge filter. The automated switch operated continuously through the day such that during each hour 50 minutes is unfiltered and 10 minutes is filtered. Approximately twice per day, an additional filtered configuration was manually triggered such that the hour was parsed into 20 minutes of unfiltered, 15 minutes of 20-μm filtration, 15 minutes of 5-μm filtration and 10 minutes of 0.2-μm filtration. Discrete water samples were collected from each of the size fractions and processed for spectrophotometric particulate absorption, HPLC and POC.

Data processing: All flow through data were processed into 1-minute bin median and standard deviation values. Observations compromised by bubbles were removed. Data were time-merged with the ship navigation GPS data streams, also processed into 1-minute bin median values. Data stream was parsed into unfiltered and filtered intervals, with transitional data removed. Filtered observations were interpolated to 1–minute intervals and subtracted from unfiltered data, thus yielding blank-subtracted fluorescence values (Slade et al. 2010).

The particle backscattering coefficient at each wavelength was computed from:

$$b_{bp}\,(m^{-1}) = M\left({m^{-1}}/{_{dc}}\right) \times \left(DC_{bb_{unfilt}} - DC_{bb_{filt}}\right).$$

Where M is the calibration slope provided by Sunstone Scientific (with a best-case accuracy of 2.1%) and DC indicates the 1-minute median digital count values for unfiltered or interpolated filtered observations.

Uncertainties and quality control concerns: Uncertainties associated with natural variations in particle backscattering were determined from the standard deviations of the one-minute bin median data for filtered, σ_{filt}, and unfiltered, σ_{unfilt}, observations. Following the Guide to Uncertainty Measurements (Jcgm 2008), the uncertainty in the particle backscattering coefficient for each channel is computed as:

$$\sigma_{bbp} = b_{bp} \times \sqrt{{\sigma_{unfilt}}^2 + {\sigma_{filt}}^2 + \left(\frac{\sigma_M}{M}\right)^2}$$

where $\sigma_M$is the calibration uncertainty.

Data products originating with this method:

Parameter	Symbol	Units
bbp (412 nm, 595 nm, 715 nm,)	b_{bp} (412) b_{bp} (595) b_{bp} (715)	mg m^{-3}

Key method references:

Dall'olmo, G., T. K. Westberry, M. J. Behrenfeld, E. Boss, and W. H. Slade. 2009. Significant contribution of large particles to optical backscattering in the open ocean. Biogeosciences **6:** 947-967.

Jcgm, W. G. 2008. Evaluation of measurement data - Guide to the expression of uncertainty in measurement, p. 134. *In* B. I. d. P. e. Mesures [ed.], GUM: Guide to the Expression of Uncertainty in Measurement.

Slade, W. H. and others 2010. Underway and Moored Methods for Improving Accuracy in Measurement of Spectral Particulate Absorption and Attenuation. Journal of Atmospheric & Oceanic Technology **27**.